US009093746B2

(12) **United States Patent**
Ko et al.

(10) **Patent No.: US 9,093,746 B2**
(45) **Date of Patent: Jul. 28, 2015**

(54) **WIRELESS COMMUNICATION DEVICE HAVING METAL ASSEMBLY AND CONDUCTIVE ASSEMBLY FOR REDUCING SPECIFIC ABSORPTION RATE (SAR)**

(71) Applicant: **FIH (Hong Kong) Limited**, Kowloon (HK)

(72) Inventors: **Cheng-Hung Ko**, Shindian (TW); **Chao-Wei Ho**, New Taipei (TW)

(73) Assignee: **FIH (Hong Kong) Limited**, Kowloon (HK)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/132,488**

(22) Filed: **Dec. 18, 2013**

(65) **Prior Publication Data**

US 2014/0375506 A1 Dec. 25, 2014

(30) **Foreign Application Priority Data**

Jun. 24, 2013 (TW) .... 102122425 A

(51) **Int. Cl.**

H01Q 1/38 (2006.01)
H01Q 1/24 (2006.01)
H01Q 9/04 (2006.01)
H01Q 5/371 (2015.01)

(52) **U.S. Cl.**

CPC ***H01Q 1/243*** (2013.01); ***H01Q 1/245*** (2013.01); ***H01Q 5/371*** (2015.01); ***H01Q 9/0421*** (2013.01)

(58) **Field of Classification Search**

CPC H01Q 1/38; H01Q 9/0407; H01Q 1/50
USPC .... 343/700 MS, 745, 749, 845, 850, 898
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,380,895	B1 *	4/2002	Moren et al.	343/700 MS
7,859,471	B2 *	12/2010	Bungo et al.	343/702
2008/0246674	A1 *	10/2008	Rutfors et al.	343/722
2009/0073048	A1 *	3/2009	Kim	343/700 MS
2009/0079637	A1 *	3/2009	Fukui et al.	343/700 MS

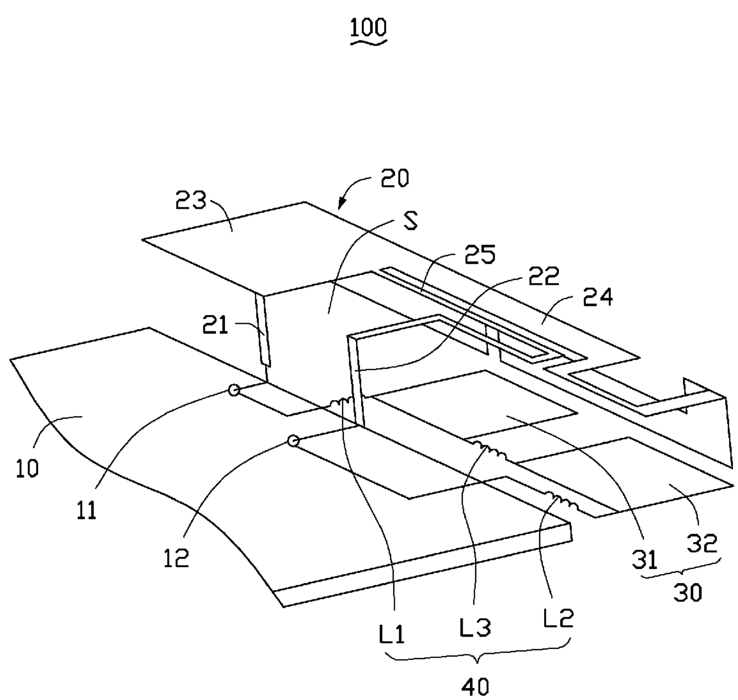
* cited by examiner

Primary Examiner — Sue A Purvis
Assistant Examiner — Jae Kim
(74) *Attorney, Agent, or Firm* — Novak Druce Connolly Bove + Quigg LLP

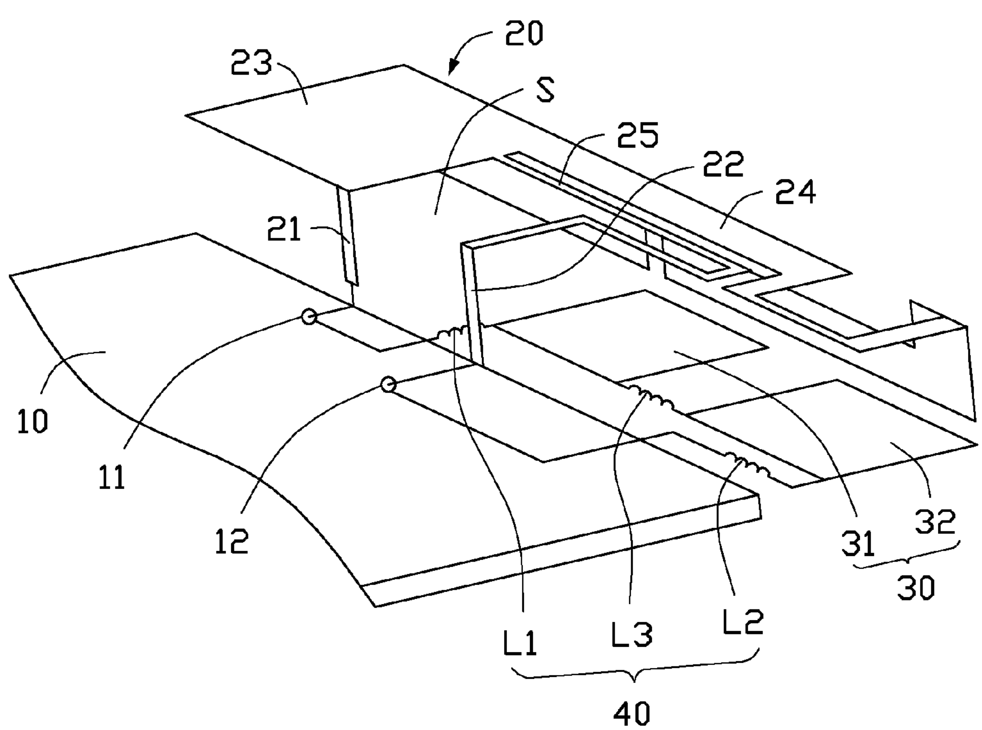
(57) **ABSTRACT**

A wireless communication device includes a base board, an antenna, a metal assembly, and a conductive assembly. The base board includes a feed portion and a ground portion, and defines a keep-out-zone. The antenna is located above the keep-out-zone, and is electronically connected to the feed portion and the ground portion. The metal assembly is located at the keep-out-zone, and is spaced from the antenna. The metal assembly is electronically connected to the feed portion and the ground portion through the conductive assembly.

9 Claims, 1 Drawing Sheet



100



WIRELESS COMMUNICATION DEVICE HAVING METAL ASSEMBLY AND CONDUCTIVE ASSEMBLY FOR REDUCING SPECIFIC ABSORPTION RATE (SAR)

BACKGROUND

1. Technical Field

The present disclosure relates to a wireless communication device employing an antenna.

2. Description of Related Art

A dual-band antenna is commonly a planar antenna, which includes a first radiating portion for transmitting/receiving wireless signals at high frequencies and a second radiating portion for transmitting/receiving wireless signals at low frequencies The first and second radiating portions are usually connected to a feed end of the dual-band antenna. During testing of specific absorption rate (SAR) of the dual-band antenna, current from the feed end may be added together. Since the SAR mainly depends on the current intensity of the antenna, thus SAR at the feed end becomes too high, which may negatively influence users.

Therefore, there is room for improvement within the art.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the disclosure can be better understood with reference to the drawings. The components in the drawings are not necessarily drawn to scale, the emphasis instead being placed upon clearly illustrating the principles of the disclosure. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the views.

The FIGURE is an isometric view of a wireless communication device, according to an exemplary embodiment.

DETAILED DESCRIPTION

The disclosure is illustrated by way of example and not by way of limitation in the FIGURES of the accompanying drawings in which like references indicate similar elements. It should be noted that references to “an” or “one” embodiment in this disclosure are not necessarily to the same embodiment, and such references mean “at least one.”

The FIGURE shows a wireless communication device **100** according to an exemplary embodiment. The wireless communication device **100** may be a mobile phone or a personal digital assistant, for example.

The wireless communication device **100** includes a base board **10**, an antenna **20**, a metal assembly **30**, and a conductive assembly **40**. The antenna **20** is located above the base board **10**, the metal assembly **30** and the conductive assembly **40** are positioned at a side of the base board **10**.

The base board **10** is a printed circuit board (PCB) of the wireless communication device **100**, and is made of composite materials. A feed portion **11** and a ground portion **12** are electrically mounted on the base board **10**. The feed portion **11** provides current to the antenna **20**, and the antenna **20** is grounded by the ground portion **12**. In one exemplary embodiment, the feed portion **11** is a circular shaped metal

sheet, current on a center of the feed portion **11** is greater than current on other positions of the feed portion **11**.

A keep-out-zone S is defined at a side of the base board **10**. The purpose of keep-out-zone S is to not permit other elements (such as a camera, a vibrator, a speaker, etc.) on the base board **10** to be placed in a predetermined area where it may interfere with the antenna. In one exemplary embodiment, The antenna **20** is located above the keep-out-zone S, the metal assembly **30** and the conductive assembly **40** are positioned at the keep-out-zone S.

In one exemplary embodiment, the antenna **20** is a planar inverted-F antenna (PIFA), and includes a feed end **21**, a ground end **22**, a connection body **23**, a first radiator **24**, and a second radiator **25**. The feed end **21** is electronically connected to the center of the feed portion **11**. The connection body **23** is a rectangular sheet, and is perpendicularly connected to a distal end of the feed end **21**. Both of the first radiator **24** and the second radiator **25** are connected to the connection body **23**, and a gap (not shown) is defined between the first radiator **24** and the second radiator **25**. The ground end **22** is electronically connected to the ground portion **12**, and the second radiator **25** is perpendicularly connected to the ground end **22**. In one exemplary embodiment, the antenna **20** can receive/transmit wireless signals having the central frequency of about 1852 MHz, 1880 MHz, and 1908 MHz.

Since the feed end **21** is electronically connected to the center of the feed portion **11**, current from the feed portion **11** is gathered around the feed end **21**. For example, the current from the feed portion **11** is gathered at the feed end **21** and the connection body **23**.

The metal assembly **30** includes a plurality of metal sheets. In one exemplary embodiment, the metal assembly **30** includes a first metal sheet **31** and a second metal sheet **32**. The first metal sheet **31** and the second metal sheet **32** are located at the keep-out-zone S, and are spaced from the first radiator **24** and the second radiator **25**.

The conductive assembly **40** is connected between the base board **10** and the metal assembly **30**. In one exemplary embodiment, the conductive assembly **40** includes a first inductor L1, a second inductor L2, and a third inductor L3. The first inductor L1 is connected between a peripheral edge of the feed portion **11** and the first metal sheet **31**. The second inductor L2 is connected between the second metal sheet **32** and the ground portion **12**. The third inductor L3 is connected between the first metal sheet **31** and the second metal sheet **32**.

Referring to the table 1, when the metal assembly **30** and the conductive assembly **40** are incorporated into the wireless communication device **100**, the specific absorption rate (SAR) of the antenna **20** is significantly reduced. For example, when the antenna **20** receives/transmits wireless signals having the central frequency of about 1852 MHz, the SAR of the wireless communication device **100** is reduced about 0.19 (1.14–0.95=0.19).

The table 1 sets out a relation among frequencies, SAR of the wireless communication device **100** having the metal assembly **30** and the conductive assembly **40**, and SAR of the wireless communication device **100** lacking the metal assembly **30** and the conductive assembly **40**:

Signal	Frequencies (MHz)	SAR of the wireless communication device 100 lacking the metal assembly 30 and the conductive assembly 40 (1 g)	SAR of the wireless communication device 100 having the metal assembly 30 and the conductive assembly 40 (1 g)
WCDMA BAND 2	1852	1.14	0.95
	1880	1.42	1.06
	1908	1.85	1.37

The table 2 shows that when the metal assembly **30** and the conductive assembly **40** are incorporated into the wireless communication device **100**, the insertion loss efficiency of the antenna **20** is significantly reduced, and the radiation efficiency of the wireless communication device **100** is greater than 20 percent, thereby satisfying communication standards.

Table 2 sets out a relation among frequencies, an insertion loss efficiency of the antenna **20**, and a radiation efficiency of the wireless communication device **100**:

Signal	Frequencies (MHz)	Wireless communication device	Radiation efficiency of the antenna	Insertion loss efficiency of the antenna	Radiation efficiency of the wireless communication device
WCDMA BAND 2	1852	Lacking the metal assembly 30 and the conductive assembly 40	31.30%	81.50%	25.30%
		Having the metal assembly 30 and the conductive assembly 40	28.70%	75.50%	21.70%
	1880	Lacking the metal assembly 30 and the conductive assembly 40	31.60%	87.10%	27.50%
		Having the metal assembly 30 and the conductive assembly 40	29.10%	81.00%	23.60%
	1908	Lacking the metal assembly 30 and the conductive assembly 40	31.70%	92.60%	29.00%
		Having the metal assembly 30 and the conductive assembly 40	29.30%	89.20%	26.00%

Since the metal assembly **30** is located at the keep-out-zone S, and is electronically connected to the base board **10** through the conductive assembly **40**, a proportion of the current can be absorbed by the metal assembly **30**, thereby reducing the current intensity on the feed end **21** of the antenna **20** and changing distributions of the current on the antenna **20**. Thus, the SAR of the antenna **20** is significantly reduced. Additionally, the first inductor L1 is connected to the peripheral edge of the feed portion **11** to obtain small current, thus, the radiation efficiency of the wireless communication device **100** will not be negatively influenced.

In other exemplary embodiments, the conductive assembly **40** can be a plurality of capacitors.

In summary, the conductive assembly **40** obtains a proportion of the current from the base board **10**, and the metal assembly **30** absorbs the proportion of the current. Thus, the current flowing to the antenna **20** is reduced, and the antenna **20** has a dispersed and even electromagnetic radiation field and obtains a reduced SAR.

It is to be understood, however, that even through numerous characteristics and advantages of the present disclosure have been set forth in the foregoing description, together with details of assembly and function, the disclosure is illustrative only, and changes may be made in detail, especially in the matters of shape, size, and arrangement of parts within the principles of the disclosure to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.

What is claimed is:

1. A wireless communication device, comprising:

a base board having a feed portion and a ground portion, a keep-out-zone defined at a side of the base board;

an antenna located above the keep-out-zone, and electronically connected to the feed portion and the ground portion;

a metal assembly located within the keep-out-zone, and spaced from the antenna; and

a conductive assembly;

wherein the metal assembly comprises a first metal sheet and a second metal sheet, the conductive assembly comprises a first inductor, a second inductor, and a third inductor, the first inductor is connected between the feed portion and the first metal sheet, the second inductor is connected between the second metal sheet and the ground portion via a path that does not include the third inductor, the third inductor is connected between the first metal sheet and the second metal sheet wherein the metal assembly is electronically connected to the feed.

2. The wireless communication device as claimed in claim **1**, wherein the feed portion is a circular shaped metal sheet having a center and a peripheral location surrounding the center, the antenna is connected to the center of the feed portion.

3. The wireless communication device as claimed in claim **2**, wherein the first inductor is connected to the peripheral location of the feed portion.

4. The wireless communication device as claimed in claim 1, wherein the antenna comprises a feed end and a ground end, the feed end is electronically connected to the feed portion, and the ground end is electronically connected to the ground portion.

5. The wireless communication device as claimed in claim 4, wherein the antenna further comprises a connection body, a first radiator, and a second radiator, the connection body is a rectangular sheet, and is perpendicularly connected to a distal end of the feed end, both of the first radiator and the second radiator are connected to the connection body, and the second radiator is perpendicularly connected to the ground end.

6. A wireless communication device, comprising:

a base board having a feed portion for providing current;

an antenna located above the base board, and electronically connected to the feed portion to receive the current;

a metal assembly spaced from the antenna; and

a conductive assembly electronically connected to the feed portion and metal assembly;

wherein the metal assembly comprises a first metal sheet and a second metal sheet, the conductive assembly comprises a first inductor, a second inductor, and a third inductor, the first inductor is connected between the feed portion and the first metal sheet, the second inductor is connected between the second metal sheet and the ground portion via a path that does not include the third inductor, the third inductor is connected between the first metal sheet and the second metal sheet; and

wherein the first inductor obtains a proportion of the current from the feed portion, and the metal assembly absorbs the proportion of the current.

7. The wireless communication device as claimed in claim 6, wherein the base board defines a keep-out-zone, the antenna is located above the keep-out-zone, and the metal assembly located at the keep-out-zone.

8. The wireless communication device as claimed in claim 6, wherein the feed portion is a metal sheet with circular shape having a center and a peripheral location surrounding the center, the antenna is connected to a center of the feed portion.

9. The wireless communication device as claimed in claim 8, wherein the first inductor is connected to the peripheral location of the feed portion.

* * * * *